

STORAGE STUDIES ON EXTRUDED SORGHUM PRODUCTS

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ABSTRACT

Extrusion is a thermal process which has permitted large number of food applications. The objective of this research was to study the storage characteristics of the extruded sorghum products. The samples prepared from blends of sorghum, broken rice and green gram with higher expansion ratio and lower bulk density values were taken for storage studies. The products were packed in LDPE (Low density polyethylene) and ALPE (Aluminium lined polyethylene) (and kept for 3 months and analysed for every 30 days interval. The moisture content, protein and carbohydrate content were analysed. The moisture content of the samples packed in LDPE showed increase in moisture content.

KEYWORDS: Sorghum Extruded Products, LDPE, ALPE, Sorghum Based Products

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INTRODUCTION

Sorghum species (*Sorghum vulgare* and *Sorghum bicolor*) are members of the grass family. Sorghum (*Sorghum bicolor*) is the world's fifth leading grain in production. Sorghum is less expensive than other cereals. Because of its lower cost, sorghum is an attractive ingredient for the production of extruded snacks or breakfast cereals. Sorghum flakes will be a good alternative for corn flakes as breakfast cereal and as adjuncts in brewing industry.

Rice is grown as a monocarpic annual plant in tropical areas. Rice is a cereal foodstuff which forms an important part of the diet of many people worldwide, including India. Broken rice possibly due to non-availability of technology for its conversion to value added products and developments of taste and social consideration, they are used in flour form in traditional recipes. There are no major industrial processes for effective utilization of broken rice, so there is scope for the research which utilizes the broken rice.

Legumes are particularly high in protein, mineral, cholesterol-free, high in dietary fibers and low in saturated fat. India is the largest producer of mungbean (*Vigna radiata*) and is 3rd most important pulse crop of India (Choudhary *et al.*, 2011) which is rich in quality proteins, minerals and vitamins.

Extrusion cooking, as a multi-step, multi-functional and thermal/mechanical process, has permitted a large number of food applications (Singh *et al.*, 2007). Extrusion cooking is probably most promising food-processing techniques in terms of continuous process with high productivity and to produce a wide variety of food products. Extrusion processing of sorghum flour has been shown to improve sorghum protein solubility and functionality. High-temperature, short-time extrusion cooking could be used to produce sorghum-based snack products of high nutritional quality and in a ready-to-eat form. In view of these, the project was undertaken to

study the storage characteristics of extruded sorghum products.

MATERIALS AND METHODS

The storage studies were conducted in the college of Agricultural Engineering and Post harvest technology centre, Bapatla.

Preparation of the Samples for Storage Studies

The products prepared from blends of sorghum, rice and green gram with high expansion ratio and low bulk densities were packed in two different packaging materials i.e. LDPE (Low density polyethylene) and ALPE (Aluminum lined polyethylene) and kept for 3 months at normal room temperature. After every period of 30 days the stored samples were analyzed for changes in moisture content, carbohydrates and protein content. Based on these properties, the shelf life of the extruded samples was reported.

Packaging Materials

LDPE is defined by a density range of 0.910–0.940 g/cm³. It is not reactive at room temperatures, except by strong oxidizing agents, and some solvents cause swelling. It can withstand temperatures of 80 °C continuously and 95 °C for a short time. Made in translucent or opaque variations, it is quite flexible and tough and moisture resistant.

Aluminium's ability to form any shape and its protective qualities has made it the most versatile packaging material in the world. An aluminium lined polyethylene is a type of food packaging made from a laminate of flexible plastic and metal foils. It allows the sterile packaging of a wide variety of foods. It is hygienic, non-toxic, retains flavor and protects from moisture, light and gases.

Estimation of Moisture Content

Moisture content of the samples was determined by using hot air oven method for every 30 days. A sample of 5gm was accurately measured into a clean and dry moisture boxes of known weight and dried in a hot air oven at 105°C for 12-15 hrs, cooled in a dessicator and weighed (AOAC, 1990).

$$\text{Moisture content (w.b)} = \frac{\text{initial weight} - \text{final weight}}{\text{sample weight}} * 100$$

Determination of Carbohydrates

(AOAC, 1990)

Reagents

- 2.5 N HCl (21.5 ml conc. HCl + 78.5 ml distilled water)
- Anthrone reagent: 200mg anthrone dissolved in 100 ml of ice cold 95% H₂SO₄.
- Stanard glucose: Stock- 100mg glucose dissolved in 100 ml of distilled water.
- Working standard: 10 ml of sock solution diluted to 100 ml with distilled water.

Procedure

- A 100mg of sample was weighed and placed in boiling test tube.
- The sample was hydrolyzed by keeping in a boiling water bath for 3hrs with 5ml of 2.5N HCl and cooled to room temperature.
- After cooled to room temperature it was neutralized with solid Na_2CO_3 until the effervescence ceases.
- The volume was made up to 100ml and then centrifuged.
- The supernatant was collected and 0.05ml and 0.1ml aliquots were taken.
- The standards were prepared by taking 0.2ml, 0.4ml, 0.6ml, 0.8ml, 1ml and a blank and the volume made up in all the tubes to 1ml with distilled water.
- Then 4ml of anthrone reagent was added and heated for 8min in a boiling water bath.
- The tubes were cooled under tap water and the readings were taken at wave length 630nm.
- A standard curve was drawn by plotting concentration of standard on X-axis and absorbance on Y-axis. From the graph the amount of carbohydrates present in the sample tube was calculated.

$$\text{Mg of glucose} = \frac{\text{O.D of sample}}{\text{O.D of standard}} * \text{concentration of standard}$$

Amount of carbohydrates present in 100g of sample

$$= \frac{\text{Mg of glucose}}{\text{volume of test sample}} * 100$$

Determination of Protein Content by Micro Kjeldhal Method (AOAC, 1990)

Reagents

The reagents required for digestion, distillation and titration are given below respectively.

Digestion

- 98% pure concentrated sulphuric acid 10ml per sample.
- Catalyst mixture or digestion mixture or activator (5:1) for each tube. Potassium sulphate (100gm) and copper sulphate (20gm).

Distillation

- 40% NaOH (400gm of NaOH in 1lit of distilled water)-40ml per sample.
- 4%Boric acid: 40gm in lit of distilled water-25ml/sample.
- Mixed indicator: 2parts of methyl red indicator, 1 part of Bromocresol green.

Titration

- 0.1N HCl or H_2SO_4

Procedure

Digestion

- A sample of 0.1g to 1g was weighed and transferred in to the digestion tube.
- 10-15ml of concentrated sulphuric acid and 5-7g of digestion activator was added to the sample.
- The digestion tubes were loaded into the digester and the digestion block was heated.
- The blank temperature was maintained between 320⁰ C and 410⁰ C.
- The chance of nitrogen escape is unavoidable. The sample turned colourless to light green colour at the end of digestion process.

Distillation

After neutralization, acid in the digested sample was distilled with 40% NaOH on heating in SUPRA-LX, the digested samples were heated by passing steam and ammonia was liberated due to addition of 40% NaOH dissolved in 4% Boric acid.

Titration

The solution of boric acid and mixed indicator containing the liberated ammonia was titrated against 0.1N HCl.

The titration value of blank solution of boric acid and mixed indicator was determined.

Calculations

The percentage of nitrogen present in the given sample = $\frac{(\text{sample titre value} - \text{blank titre}) * \text{No of acid} * 14 * 100}{\text{sample weight} * 1000}$

The percentage of protein present in the given sample

= % N * 6.25 factor

RESULTS AND DISCUSSIONS

Effect of Packaging Material and Storage Conditions on Moisture

Increase in moisture content was observed in stored extruded products packed in the LDPE covers. Initially the products had moisture content ranging from 6.9 to 7.6% (w. b) and it increased to 8.8 to 8.8% (w. b) as shown in the Table1. The m.c of extrudates stored in LDPE is shown in Figure 1. The products packed in ALPE showed decrease in the moisture content. The final moisture content ranged from 6.3 to 6.7% (w. b) as shown in the Table1. The m.c of the extrudates stored in ALPE is shown in Figure 2.

Table 1: Variation in Moisture Content of the Samples Packed in LDPE & ALPE

S. No	Packing Material	0 th day	30 th day	60 th day	90 th day
S ₂	LDPE	7.1	8.2	8.5	8.7
	ALPE		6.8	6.7	6.6
S ₃	LDPE	7.2	8.4	8.7	8.8
	ALPE		7	6.8	6.7
S ₅	LDPE	7.2	8.2	8.5	8.6
	ALPE		6.7	6.5	6.4

S ₆	LDPE	7.4	8.4	8.6	8.7
	ALPE		6.7	6.5	6.4
S ₉	LDPE	7.6	8	8.3	8.6
	ALPE		7	6.7	6.6
S ₁₂	LDPE	7	8.3	8.7	8.8
	ALPE		6.6	6.4	6.3
S ₁₄	LDPE	7.1	8	8.3	8.5
	ALPE		6.8	6.6	6.5
S ₁₈	LDPE	7.5	8.5	8.7	8.9
	ALPE		6.7	6.6	6.5
S ₂₁	LDPE	6.9	7.8	8.2	8.4
	ALPE		6.5	6.4	6.3

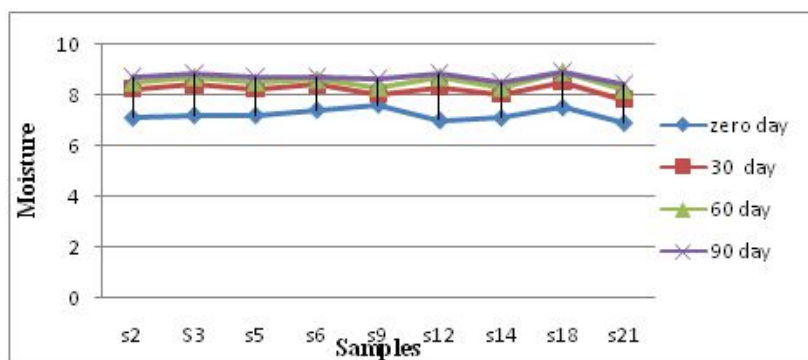


Figure 1: Effect of Moisture Content of Sorghum Based Extruded Samples Packed in LDPE

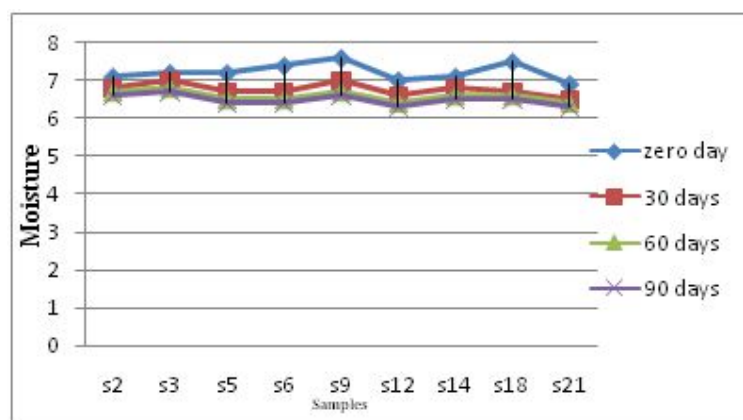


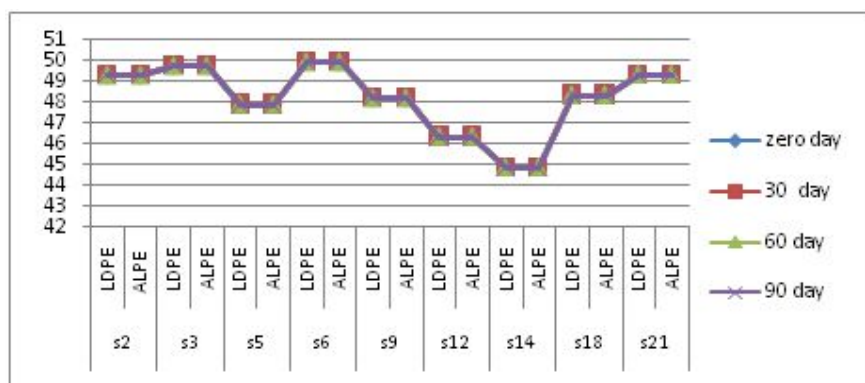
Figure 2: Effect of Moisture Content of Sorghum Based Extruded Samples Packed in ALPE

Effect of Packaging Material and Storage Conditions on Carbohydrate Content

The carbohydrate content of the samples optimized for storage studies ranged from 44.85 to 49.95g presented in Table 2. The sample S₆ has the highest carbohydrate content. The carbohydrate content of the samples stored in two packing material showed same value and there was no change in carbohydrate content during storage. The carbohydrate content of the sorghum based extruded samples is shown in Figure 3.

Table 2: Variation in Carbohydrate Content of the Samples Packed in LDPE & ALPE

S. No	Packing Material	0 th day	30 th day	60 th day	90 th day
S ₂	LDPE	49.3	49.3	49.3	49.3
	ALPE		49.3	49.3	49.3
S ₃	LDPE	49.75	49.75	49.75	49.75
	ALPE		49.75	49.75	49.75
S ₅	LDPE	47.9	47.9	47.9	47.9
	ALPE		47.9	47.9	47.9
S ₆	LDPE	49.95	49.95	49.95	49.95
	ALPE		49.95	49.95	49.95
S ₉	LDPE	48.2	48.2	48.2	48.2
	ALPE		48.2	48.2	48.2
S ₁₂	LDPE	46.35	46.35	46.35	46.35
	ALPE		46.35	46.35	46.35
S ₁₄	LDPE	44.85	44.85	44.85	44.85
	ALPE		44.85	44.85	44.85
S ₁₈	LDPE	48.35	48.35	48.35	48.35
	ALPE		48.35	48.35	48.35
S ₂₁	LDPE	49.35	49.35	49.35	49.35
	ALPE		49.35	49.35	49.35

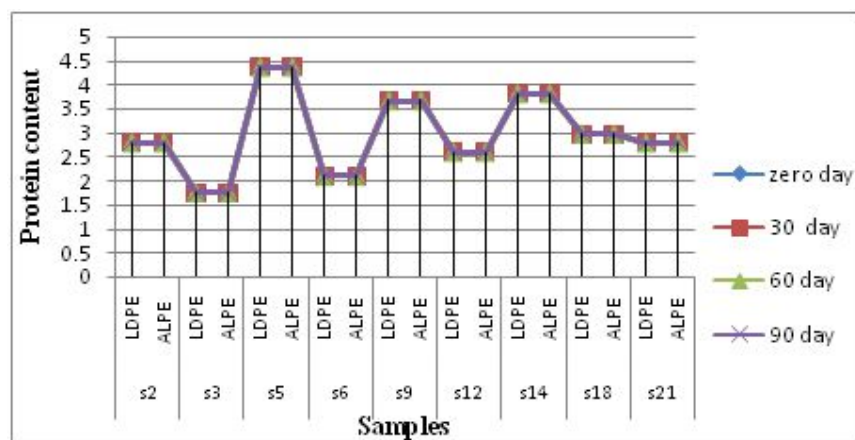
**Figure 3: Effect of Different Parameters S on Carbohydrate Content of the Sample**

Effect of Packaging Material and Storage Conditions on Protein Content

The protein content of the samples optimized for storage studies ranged from 4.37 to 1.75 g. Among the samples S₅ has the highest protein content. Proteins influence expansion through their ability to affect water distribution in the matrix and through their macromolecular structure and confirmation, which affects the extensional properties of the extruded melts (Moraru and Kokini, 2003). Similar findings were observed by (Martinez *et al.*, 1990; Onwulata *et al.*, 2001), who investigated the effects of whey protein concentrate and isolate on the extrusion of corn and rice starch and reported a reduction in expansion at higher concentrations of protein. The samples showed no change in protein content during the storage period.

Table 3: Variation in Protein Content of the Samples Packed In LDPE & ALPE

S. No	Packing Material	0 th day	30 th day	60 th day	90 th day
S ₂	LDPE	2.8	2.8	2.8	2.8
	ALPE		2.8	2.8	2.8
S ₃	LDPE	1.75	1.75	1.75	1.75
	ALPE		1.75	1.75	1.75
S ₅	LDPE	4.37	4.37	4.37	4.37
	ALPE		4.37	4.37	4.37
S ₆	LDPE	2.1	2.1	2.1	2.1
	ALPE		2.1	2.1	2.1
S ₉	LDPE	3.67	3.67	3.67	3.67
	ALPE		3.67	3.67	3.67
S ₁₂	LDPE	2.6	2.6	2.6	2.6
	ALPE		2.6	2.6	2.6
S ₁₄	LDPE	3.82	3.82	3.82	3.82
	ALPE		3.82	3.82	3.82
S ₁₈	LDPE	2.97	2.97	2.97	2.97
	ALPE		2.97	2.97	2.97
S ₂₁	LDPE	2.8	2.8	2.8	2.8
	ALPE		2.8	2.8	2.8

**Figure 4: Effect of Different Parameters on Protein Content of the Sample**

CONCLUSIONS

The effect of two different packing materials LDPE and ALPE on the shelf life of the products were studied. The extruded products were packed and stored at ambient temperatures. After evaluating the samples it was observed that the moisture content of the samples packed in LDPE showed increase in moisture content where, samples packed in ALPE showed decrease in moisture content. There was no change in the protein and carbohydrate content during storage. The study showed that the shelf life of the extruded products at ambient temperatures can be increased by using ALPE which have better barrier properties.

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